

Applied Mechanics

The INL is known for specialized applied mechanics capabilities in structures, materials, fluids and thermal behavior of systems necessary to accomplish DOE missions.

Capability Portfolio

INL's applied mechanics capabilities include nonlinear structural analysis, blast and impact evaluation, piping and pressure vessel analysis, seismic soil-structure interaction, and materials aging. These capabilities have been developed through work for Department of Energy and Nuclear Regulatory Commission programs. The structural, thermal and fluid challenges of producing nuclear power, operating experimental reactors, simulating accidents or natural hazards, and confining hazardous substances during shipment have been modeled and tested by Applied Mechanics experts.

Computational Models

INL has extensive experience in computational modeling of linear and nonlinear problems, using testing and experimentation to confirm results. Examples include the development of packaging to survive accident scenarios for the transport of spent nuclear fuel, researching fragility of boiling water reactor internal components, reduction of lifetime due to irradiation of beryllium reflectors in nuclear reactors, measuring force transfer and deflections of light frame structures in high winds and simulating in finite element models.



Comparing the impact a hazardous waste shipping canister received when dropped onto an unyielding surface to the computational model of the test, reveals the precision of the model.

INL Applied Mechanics experts perform highly specialized analysis such as high strain-rate material responses found in impact loading, and soil-structure interaction during seismic events. Analysis of piping and pressure vessels experiencing pressure and seismic loads and temperature gradients is also a strong capability. INL staff are experienced users of analysis computer codes including PipeStress, LS-Dyna, ABAQUS Explicit, IDEAS, NUPIPE-II, SASSI 2000, SAP 2000, and FLUENT. INL also develops numerical simulation methods, graphical interfaces, and is experienced in computational optimization techniques.

Assessments and Regulatory Development

Analysis experience has led to pre-and post-event structural damage field assessments and regulatory audits for structural code compliance. Seismic reviews, regulatory compliance

audits, field inspections and/or readiness reviews have been conducted at approximately 40 nuclear power plants for the Nuclear Regulatory Commission. As an example of regulatory development, INL established the basis for fatigue analyses of selected nuclear power plant components using environmentally corrected fatigue curves in NUREG/CR-6260.

Full- and Reduced-Scale Testing

INL performs full scale testing on the containment and transport of spent nuclear fuel, radioactive materials and hazardous waste. INL tests evaluate the ability to safely maintain containment of the packaging in accident scenarios and calibrate computational simulations.

Applied Mechanics experts perform natural hazard testing and experiments specific to seismic events and extreme wind scenarios. Laboratory

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Science



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tests are designed for specific knowledge: for example, measuring heat of hydration for thick-walled concrete encasements.

Testing is also performed on valve operability and vibration resistance of equipment and components in support of Nuclear Regulatory Commission programs.

For more information

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INL is a U.S. Department of
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Alliance



Testing Facilities

Facilities are available to perform a variety of research activities. Horizontal and vertical shake tables as well as instrumented hammers, accelerometers and multi-channel data acquisition systems are available for a wide variety of vibration testing options.

Numerous precision drop tests on a large capacity drop test pad have been completed at INL to evaluate design robustness and containment capabilities for various spent nuclear fuel containers. INL also has the capability for testing mechanical components (such as valves and pumps) and material property testing.

INL developed an Elevated Strain Rate Test Machine designed to measure inelastic, dynamic material properties. Using this device, Applied Mechanics experts were able to develop elevated strain rate stress-strain curves for 304L and 316L stainless steel.



The INL Impact Test Machine measures elevated strain rate material properties.



This six-foot thick pad represents an unyielding surface for drop testing hazardous material packaging.